

## SOME NEW BRACHIOPODS FROM THE MIDDLE PALAEOZOIC ROCKS OF NEW SOUTH WALES.

BY JOHN MITCHELL, LATE PRINCIPAL OF THE TECHNICAL COLLEGE AND SCHOOL OF  
MINES, NEWCASTLE.

(Plate xxxi.)

The fossils dealt with in the present paper represent seven genera and as many separate species of brachiopods. One genus and four of the species are new. Three of the genera are typically Silurian; one (*Merista*) is characteristic of Middle Devonian, and the range of the proposed new genus *Molongia* remains to be ascertained. Two of the species have previously been recorded from this State, viz., *Retzia salteri* Sowerby, by de Koninck from Yarralumla, and *Orthis striatula* Schloth. by W. S. Dun. From a palaeontological point of view, perhaps the most important of the species under notice is *Merista plebeia*, because it is so typically an index of middle Devonian age in Europe, and in North America; in these countries it has but a limited vertical range. For this reason it should be very helpful in correlating the sedimentary rocks in which it occurs, however distant apart they may be. With regard to this fossil it is to be noted that, although its existence was, apparently, only a short one geologically, its distribution was world-wide, and these remarks apply to its associate *Orthis striatula* Schloth.; in Australia, just as in Europe, these two fossils are associates, and help to confirm the assumption that the rocks in this State, from which they have been collected in association, are approximately of Devonian age, and, in that case, they would appear to form an inlier surrounded by rocks of Carboniferous age, portions of which have recently been discussed and described (These Proceedings, xlv., 1920, Pt. 2, pp. 285-316). From the same limestone have been gathered a few *Spirifers*, one of which is near if not identical with *S. pittmani* Dun and considered by him to be of Devonian age. The pentamerid, *B. molongensis*, resembles in shape juvenile forms of *Barrandella linguifer* var. *wilkinsoni* Eth., but in the latter the umbo of the ventral valve is always much more strongly developed and overhanging than it is in the former; and in the latter, too, the length always, at all stages of growth, exceeds the width, while in the former the values of these dimensions are reversed. The Molong fossil occurs with *Atrypoides australis* and *A. angusta* Mitch. and Dun. Etheridge's species

occurs with these same Atrypids at Hatton's Corner in the Bonnyongian Beds but the Hatton's Corner species has not yet been obtained from the Molong Beds.

*Spirifer bowringensis* is very characteristic of the Lower Trilobite Beds of the Bonnyongian Series, and is also one of the few individuals of the fauna of these lower beds which survive to appear in the Middle Trilobite Beds.

If the suspected occurrence of the genus *Seminula* should be proved an actuality in this Gunnenbene limestone patch, an unusual commingling of Devonian and Carboniferous genera would be the result.

It may not be out of place here to remark how very important a help it would be towards the completion of a satisfactory geological survey of the State, if full and systematic palaeontographies were made of the stratified rocks of Molong, Wellington, and Orange in conjunction with those of the Bonnyongian Beds. Besides, a work of this kind would without doubt result in many valuable palaeontological discoveries being made; for the stratified rocks of these localities are not to be surpassed for fossiliferous wealth.

#### Family MERISTELLIDAE Waagen.

##### MERISTA PLEBEIA Sowerby. (Plate xxxi., figs. 1-3.)

*Spec. Char.*—Shell biconvex, subtriangular, valves about equally convex, smooth. Pedicle valve a good deal deeper than the brachial one, strongly convex especially in front of the umbo; anteriorly depressed umbone prominent, incurved apically, truncated by a circular foramen. Brachial valve slightly more convex than the pedicle valve; in some specimens a very inconspicuous fold is present; umbo moderately prominent, strongly incurved, and overhung by that of the pedicle valve; a well developed septum present. Hinge line mildly arcuate. Cardinal angles blunt. Lateral and front margins very mildly sinuate. Only a small portion of the brachidium has been observed in one specimen.

*Dimensions.*—Four individuals gave the following measurements:—

Length 18.7 mm.	Width 18.7 mm.	Depth 11.7 mm.
" 17.3	" 17.3	" 10.2
" 15.6	" 15.2	" 9.4
" 15.6	" 15.2	" 9.4

But while these four specimens yielded fairly constant proportions for the three dimensions the following did not:—

Length 21.9 mm.	Width 17.2 mm.	Depth 12.5 mm.
" 20.85	" 18.23	" 12.5
" 21.9	" 21.9	" 12.5

\* These variable dimensions do not afford information of much value in determining its specific position.

*Obs.*—The form now dealt with bears close relationship externally to *M. plebeia* Sow. sp. and to *M. tennesseeensis* Hall and Clarke, yet differs in some respects from both.

Dimensionally, the adult specimens of *M. plebeia* and the local form closely agree in size as is shown by a comparison of the measurements of the two forms. The dimensions of *M. plebeia* given by Davidson for two specimens are (Brit. Foss. Brach., iii. 1864-71, Pl. iii., figs. 2-10)—

Length 18.75 mm.	Width 20.8 mm.	Depth 10.4 mm.
" 20.8	" 19.5	" 12.5

The length and depth of the latter specimen are practically identical with the similar measurements of one of the two large specimens of the local forms given above. In the case of the former species sometimes the length is greater than the width and sometimes the reverse; in the latter, the length is always greater than or equal to the width, as far as may be determined from the specimens at present available. In outline and external features, adult specimens of the two shells are not separable, and if the specific determination of the local shells were to be made after a comparison with the adult specimens of *M. plebeia* Sow., I would without hesitation place it with that species, but the youthful forms of the British (Plymouth) species, as represented in figs. 7-8 (*loc. cit.*) are unlike any of the youthful specimens of our form. Further the umbo and beak of the pedicle valve of the local form seem more prominent than are these parts of the British species. These slight differences may hardly justify the separation of the two.

The relationship between *M. tennesseensis* Hall and Clarke, and ours is also close. The largest specimens figured by Hall and Clarke (*Nat. Hist. N. Y., Pal.* 1894, Vol. iii., Brach. ii., Pl. xlii., figs. 1-6) have length 15.6 mm., width 14.75, depth 9.4 mm.

In figure 5 the length and width are 15.6 mms. for each dimension. By referring to the dimensions given above for local shells, the close agreement of some of them will be plain. Therefore, from dimensional evidence, these two might be placed together; but *M. tennesseensis*, judging from the figures, was smaller, and possessed a more conspicuous sulcus in the pedicle valve than the New South Wales type. The valve margins, lateral and anterior, of the latter are more sinuous than they are in the former.

After full consideration it seems to me that the Australian type might be placed with either the British *M. plebeia* or the American *M. tennesseensis* Hall and Clarke, but appears to be nearer the former than the latter; therefore it is placed with that species, though the immature specimens of our form do not appear to exactly agree with the similar British ones.

As far as I am aware this brachiopod has not previously been recorded from this State. In England it occurs plentifully in rocks of middle Devonian age.

The specimens here described and figured were collected from a mass of limestone within an extrusion of trachyte at the base of Bulga Hill, Tuleumbah, near Carroll, on the property of Mr. John Tydd. The geological age is, doubtless, middle Devonian. A brachiopod which, outwardly, bears a strong resemblance to the shells above described, was collected by the writer from Cave Flat, near the junction of the Murrumbidgee and Goodradigbee Rivers, from rocks which are referred to as lower to middle Devonian.

#### Family SPIRIFERIDAE.

*SPIRIFER BOWNINGENSIS*, n.sp. (Plate xxxi., figs. 21-22.)

*Spec. Chars.*—Shell transversely subelliptic, radially strongly ribbed, and finely and densely striated. Pedicle valve strongly convex, possesses ten to twelve folds, sulcus deep and very wide anteriorly, umbo prominent, beak pointed, incurved, and somewhat obscuring the area; folds abutting the sulcus very prominent. Brachial valve mildly convex, has ten folds exclusive of the medial one which is prominent, and medially traversed by a shallow wide sinus; beak not conspicuous. Hinge line long, straight, almost as long as the greatest width

of the shell; area short, narrow, and usually contracted by pressure; cardinal angles mildly rounded. Front margin strongly sinuate.

Dimensions.—Length 18 mm., width 29.7 mm., depth 12.5 mm.

Length 21.9 mm., width 32.8 mm., depth 15.6 mm.

The first of these measurements is of a very perfect specimen three-fourths grown. The other is of an adult specimen. The different dimensions do not seem to bear proportional relations in either case.

*Obs.*—This *Spirifer* belongs to Hall and Clarke's group I. Radiati, and section 1, Pauciplicata of that group, approaching closely to *S. radiatus* and *S. plicatellus* Sowerby externally; but more to the latter than the former, more especially to the Swedish representatives of the species. In a less degree it resembles *S. eudora* Hall, from the Niagara formations; but dimensionally is very different. Both *S. radiatus* and *S. plicatella* differ from the local species in the absence of a medial sinus on the fold of the braehial valve. The radial ribs of the former are not prominent, and diminish in this respect as they approach the umbo in the latter; they are very prominent throughout their length, except in the case of the outer rib or two on each valve. The hinge lines and areas of the two species are much alike. In adult specimens of the Bowning one there are constantly six ribs on each side of the sulcus on the pedicle valve; and on each side of the medial fold of the braehial valve the ribs are five. In the case of *S. plicatella* Sow. the ribs on the similar parts seem to be more variable in number and in prominence. The two are easily separable from each other, and the same may be said of *S. radiatus* and the local one.

This *Spirifer* is very characteristic of the Lower Trilobite Beds of the Bowning Series, where it is common and has very few other *Spirifers* for associates, but instead, numerous trilobites, among which are *Odontopleura bowningensis* E. and M., *O. parvissima* E. and M., *Ceratocephala vogdesi* E. and M., *Sphaerexochus mirus* Beyrich, *Staurocephalus murchisoni* Barr., etc.

It is one of the few representative members of the fauna of the Lower Trilobite Beds that pass upward into the Middle Trilobite Beds; and probably survives to the lower Devonian period, for some fragments of a *Spirifer* near to, if not identical with it, have been collected from the limestones near the junction of the Goodradigbee and Murrumbidgee Rivers.

*Loc. and horizon.*—Lower and Middle Trilobite Beds, Bowning, Parish of Bowning, County Harden, N.S.W. Upper Silurian—Wenlock or Barrande's étage E.

#### MOLONGIA, n. gen.

The Bowning and Molong districts of New South Wales yield a Spiriferoid Brachiopod which I have been unable to place in any of the genera of this large group. It possesses a well-defined smooth sulcus in the pedicle valve and an equally distinct median fold in the braehial valve; the spiralia too are very like those of true *Spirifers*. But they have no cardinal area, neither is an open delthyrium present; but, instead, there is a foramen truncating the apex of the pedicle beak. It seems not distantly related to Hall's genus *Trematospira*, but it lacks some of the essential features of that genus, for instance, its shell is imperforate, and within the sulcus of the pedicle valve there are no folds. Failing to be satisfied that it can be placed in any existing genus, a new genus is proposed for its reception.

*Gen. char.*—Shell imperforate; umbo of pedicle valve prominent, incurved, depressed, and truncated by a circular foramen; cardinal area absent; hinge-line straight or nearly so; spiralia spiriferoid. Other internal structures not observed.

*Genotype*, *Molongia elegans*, n.sp.

*MOLONGIA ELEGANS* n.sp. (Plate xxxi., figs. 6-8, 12.)

*Spec. char.*—Valves strongly convex, the pedicle valve more so than the other. Pedicle valve subrhomboidal, sulcus deep, smooth and wide, and on each side of it are four radial ribs, all of which are prominent, except the one on each side adjacent to the cardinal angles. Umbo prominent, incurved, truncated by a circular foramen and resting on the umbo of the brachial valve, or nearly so. Brachial valve subquadrate, medial fold prominent and medially traversed by a narrow, shallow sinus; the lateral folds agree in number and character with those of the ventral valve, and alternate with them, thus giving to the lateral margins a zig-zag outline; umbo moderately prominent, and fills up the delthyrium. Hinge-line straight, or almost so, and reaches to the cardinal angles which are nearly rectangular in perfect and mature specimens. Hinge-line elevated. The whole surface of the shell is traversed by faint, undulating, concentric growth-lines.

*Obs.*—This fossil in several respects is very spiriferoid, and in other features it approaches forms of *Trematospira*.

*Loc. and horizon.*—About eight miles west of Molong, Parish of Bomey, County Wellington; Bowring, Parish of Bowring, County Harden. In both localities it is associated with *Atrypoides australis* Mitchell and Dun. Apparently Upper Silurian.

#### Family RETZIIDAE.

*RETZIA SALTERI* Davidson. (Plate xxxi., figs. 4-5.)

*Terebratula salteri*, Dav., Bull. Soc. Geol. France, 2nd ser., vol. v., 1848, p. 331, Pl. iii., fig. 31; *Retzia salteri*, Schmidt, Sil. Form. Ehsland, etc., 1858, p. 212; Salter, Siluria, 2nd edit., 1859, p. 250, Foss. 57, fig. 7; *R. baylei*, Lindstrom, Gottlands Brachiop., Ofvers. K. Vet.-Akad., Forhandl., 1860, p. 337; *R. salteri*, de Koninck, Mem. Geol. Surv. N. S. Wales, Pal. No. 6, 1898, p. 27.

*Spec. char.*—Shell equally and strongly convex, oval; valves almost of equal size and each medially depressed. In the depressed part of the pedicle valve are two less robust ribs than those on the lateral parts of the valve, and, in the corresponding depression of the brachial valve, there is one such rib even less distinct than those of the pedicle valve. On each side of these depressed ribs, in each valve there are ten, simple and relatively strong ribs, making a total of twenty two and twenty one on the pedicle and brachial valves, respectively. The umbo of the pedicle valve is only moderately prominent, incurved and apically truncated by a foramen. The umbonal parts of each are strongly inflated. Hinge line short and arcuate. Deltidial plates obscured. Margins practically non-sinuate. On one side of our solitary specimen which is weathered the spiral lamellae are sufficiently exposed to show that they possess the characteristics of the genus. The concentric growth lines are fine, numerous and asperate.

*Dimensions.*—Length, 5.25, width, 6 and depth, 3 lines respectively. These measurements agree fairly closely with those given by Davidson for *R. salteri*



and its varieties, *R. bouchardii* and *R. baylei* (Brit. Foss. Brach., iii., pp. 126-128.).

*Obs.*—The form here described agrees with *R. salteri* Dav. in (i.) valves equally convex; (ii.) small incurved beak; (iii.) medial radial ribs finer and at a lower level than the lateral ribs; (iv.) strong convexity of the valves; (v.) having in the ventral valve a low narrow sinus extending from the beak to the front margin; (vi.) valves ornamented with fine concentric lines; (vii.) having the front margin slightly indented; (viii.) having the central ribs smaller and at a lower level than the lateral ones. It differs from that species in the depressed central area having fewer ribs and a smaller number of lateral ribs. With *R. bouchardii*, it agrees in being almost as long as wide, and in the number and character of the lateral ribs. It appears to differ from that species in having only two depressed central ribs in the ventral valve and one in the dorsal valve. The local specimen is smaller; this has little significance when only a single specimen is available for comparison. Were I convinced that *R. bouchardii* was an established variety of *R. salteri* I would not hesitate to place our form with that variety. Salter, Lindström, and de Koninck considered that *R. bouchardii* and *R. baylei* of Davidson were inseparable from *R. salteri*.

de Koninck (Mem. Geol. Surv. N.S.W., Pal. 6, p. 27) recorded the species from Yarralumla, N.S.W., and gave an outline of Davidson's description of the species, which he applied to the Yarralumla form; he did not figure it, but stated that it exactly agreed with Davidson's fig. 27a, Pl. xii. Our fossil closely resembles fig. 29 of the same plate, that is, the varietal form *R. bouchardii* Dav.

The specimens dealt with by de Koninck were destroyed by fire in 1882. The occurrence of the genus *Retzia* in Australia adds another to the list of brachiopods which have a world-wide distribution which, in the case of this genus, appears to have been accomplished in a relatively short geological period.

*Loc. and horizon.*—The limestone bed of Limestone Creek, beneath the Lower Trilobite Beds of Bowring-Yass series. Parish of Derrungullen, County King. Upper Silurian (= Wenlock).

This fossil was found associated with *Favosites gothlandica* Linn., *F. basaltica* Gold., *F. multitabulata*, *Sphaerexochus mirus*, *Atrypa reticularis* Linn., *A. pulchra* M. and Dun, etc.

#### Family PENTAMERIDÆ.

##### *BARRANDELLA MOLONGENSIS*, n.sp. (Plate xxxi., figs. 9-11.)

*Spec. char.*—Shell subpentagonal to subtriangular, small, smooth, biconvex. Pedicle valve strongly convex, especially in the umbonal region, umbone prominent, beak short, depressed, gently incurved, but not overhanging the beak of the brachial valve; medial sinus wide and shallow (in some specimens being hardly visible, and in some, where it is more pronounced, there are traces of one or two faint folds within it, and on the shells of young individuals neither sinus nor opposing fold is present); anteriorly mildly to moderately sinuating the brachial valve. Brachial valve relatively small, moderately convex near the umbo, laterally and anteriorly more or less depressed, fold varies much in prominence, corresponding in this respect with the sulcus of the opposing valve in some individuals; anteriorly its prominence is increased by the shell surface on each side of it being depressed (a feature common to *B. linguifera* Sow.), umbo moderately pro-

minent, beak small, always visible. Hinge line straight or very mildly arcuate, cardinal angles rounded. The septa are short.

Dimensions of adult individuals.—

Length 10.5 mm.	Width 13.5 mm.	Depth, 8.3 mm.
„ 8.3	„ 12.	„ 7.
„ 10.4	„ 13.	„ 8.3
„ 10.4	„ 12.	„ 7.8

These measurements are fairly proportional.

*Obs.*—In some respects this species resembles youthful individuals of *B. linguifera* var. *wilkinsoni* Eth. Jr., and is suggestive of having been derived from that species by the arrest of its development in the early stages of growth, but at no stage of development can the one form be mistaken for the other. Dimensionally they are widely different,—the one seldom reaching a length of 10.5 mm. and only rarely exceeding 13 mm. in width, while the other may reach 25 mm. for each of these dimensions. The width in the Molong species is always much greater than the length, but in the other the width only very slightly exceeds the length. This fossil occurs in clusters, numbering hundreds of individuals occasionally in a cluster in a massive bed of grey limestone associated with *Atrypoides australis* Mitch. and Dun, *A. angusta* Mitchell and Dun, *Leptaena rhomboidalis* Wilckens, etc.

*Loc. and horizon.*—Some eight miles west of Molong, Parish of Bomey, County Wellington. Probably Upper Silurian.

SIEBERELLA GLABRA, n.sp. (Plate xxxi., figs. 13-15.)

*Spec. Chars.*—Shell smooth, thick, subpentagonal or subquadrate according to stage of growth, concentric lines faintly visible on some specimens. Pedicle valve very convex, umbo very tumid and prominent in adult specimens. Beak acutely pointed, incurved and strongly depressed on to that of the brachial valve. Fold only moderately conspicuous, originating just in front of the umbonal region and terminating with a straight edge at the anterior sinus. Hinge line wide, cardinal angles high and rounded. Brachial valve only moderately convex in the posterior half, laterally flat to subconcave; sinus wide, shallow and moderately indenting the opposing valve.

*Dimensions* (adult specimens).—Length, 21, 21.9 mm.; width, 21, 20.8 mm.; depth, 16.5, 13.0 mm.; (specimen of medium growth), length 15.6, width 18.7, depth 8.8 mm.

From these measurements the development of the shell would appear to have been very variable in different individuals, or rather at different stages of growth.

*Obs.*—This shell is different from the old *Sieberella* (*Pentamerus*) *galeatus* in several particulars, so evident that their enumeration is unnecessary. The radial ribbing characteristic of the genus is practically absent from the Australian species, for the only traces found on it are very faint folds on each side of the sinus anteriorly, and an equally faint and hardly visible fold on the medial part of this sinus.

Specifically, as far as my knowledge enables me to judge, the species here described has no very close relation among the species occurring in Europe and America.

Up to the stage of medium growth, the umbo of the pedicle valve of *S. glabra* is not prominent, and the beak does not overhang that of the brachial

valve; but from that to the adult stage the umbo and umbonal regions strongly develop; and so throw the pedicle valve beak on to that of the brachial valve.

In the classification of this brachiopod I have adopted the divisions proposed by Hall for galeatiform pentamerids (Pal. N.Y., Vol. viii., Brach., ii., 1894, pp. 240 and 247).

*Loc. and horizon.*—Hatton's Corner, Yass River, Parish of Hume, County Murray, associated with *Barrandella (Clorinda) linguifera* var. *wilkinsoni* Eth. Junr., *Atrypa reticularis* Linn., *Rhizophyllum interpunctatum* de Kon., *Encrinurus mitchelli* Foerste, etc. Upper Silurian (Wenlock).

#### Family ORTHIDAE.

##### ORTHIS (SCHIZOPHORIA) STRIATULA Sowerby. (Plate xxxi., figs. 16-20.)

*Spec. Chars.*—Outline subcircular or subelliptic, transversely biconvex, surface densely covered with fine radial striae which increase in number anteriorly with the growth of the shell by dichotomy and occasional interpolations; at intervals the larger striae open to the surface and discontinue. All the striae along their whole length are surmounted by slight asperities; concentric growth lines faint except anteriorly. Pedicle valve distinctly convex except anteriorly, where it becomes depressed, and in senile shells a distinct sulcus is formed; beak only slightly incurved and higher than that of the brachial valve. Brachial valve more convex than pedicle, beak incurved. Cardinal area of moderate length, triangular, elevated in each valve. Delthyrium conspicuous. Cardinal angles rounded. Anterior margin in immature shells very mildly sinuate; rather strongly in some of full growth.

##### *Dimensions* (mature and nearly mature specimens).—

Length	20.3 mm.	Width	23.4 mm.	Depth	15.6 mm.
"	20.3	"	23.3	"	12.5
"	17.2	"	22.6	"	11
"	17.2	"	22.7	"	12.5
"	20.7	"	25.0	"	12.5

These measurements show proportionate relations more or less, for the three dimensions. The first, which has the greatest thickness, has also the appearance of greatest age; it would appear that depth continued to increase after the other dimensions had reached their full development.

*Obs.*—Some palaeontologists have contended that *O. (Sch.) striatula*, is identical with *O. (Sch.) resupinata*; but a larger number recognise its specific rank. The Australian representatives of the species are of smaller size than the European and North American forms; but agree with them in external features. The local *O. (Sch.) striatula* has only half the width and length of the local *O. (Sch.) resupinata* Martin, but in depth often exceeds the latter, in the case of full grown specimens, and is much more convex. In no instance have I noticed the anterior marginal sinus so pronounced in the latter as it is in the former when the shells are of mature growth. The muscular scars of the former, as far as my observations have enabled me to decide, are less distinct than are those in the latter, and in other respects the scars appear to differ. The local fossil seems nearer in form and dimensions to the North American form than to the British one.

The specimens here dealt with occur in association with *Merista plebeia* Sowerby; and in that respect agree with the European and North American asso-



ciations. Other associates are some *Spirifers*, one of which has a strong resemblance to *S. pittmani* Dun, and with what appears to be a species of the genus *Seminula* which would be an unexpected associate.

*Loc. and horizon.*—Tydd's farm, Tuleumbah, Parish of Gunnenbene, County Nandewar. If judged from the presence of *Merista plebeia*, the horizon would certainly be declared Middle Devonian; but should the presence of *Seminula* be proved, then the geological horizon of the rocks from which the fossils were obtained will be a matter for reconsideration.

#### EXPLANATION OF PLATE XXXI.

- Figs. 1-3.—*Merista plebeia* Sewerby. Ventral, brachial and profile views of mature specimens.
- Figs. 4-5.—*Retzia salleri* Davidson. Ventral aspect and weathered side of a specimen. In the latter six turns of a spiral are exposed.
- Figs. 6-8 and 12.—*Molongia elegans* Mitchell. Dorsal, ventral, and profile views of three mature specimens (x 2); Fig. 12 has the dorsal valve removed to show the spires, enlarged.
- Figs. 9-11.—*Barrandella molongensis* Mitchell. Dorsal, ventral, and front views of three nearly mature specimens (x 2).
- Figs. 13-15.—*Sieberella glabra* Mitchell. Dorsal, ventral, and front views. Figs. 13 and 14 are of adult specimens, Fig. 15 represents a shell of medium size.
- Figs. 16-20.—*Orthis (Schizophoria) striatula* Schloth. In figs. 16-19 the ventral, oblique, front and cardinal aspects are shown. Fig. 20 is the part of a cast to show the muscular scars of the pedicle valve. (x 3).
- Figs. 21-22.—*Spirifer bowringensis* Mitchell. Fig. 22 shows a specimen three-fourths grown (x  $\frac{1}{3}$ ), and fig. 21 is part of a valve (x 3) to show the radial striae, etc.